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AN OBSERVATION RELATING TO THE NATURE OF AURICULAR FIBRILLATION.

By THOMAS LEWIS.

Reprinted from "Heart."
Vol. IV, No. 3, May 29, 1913.

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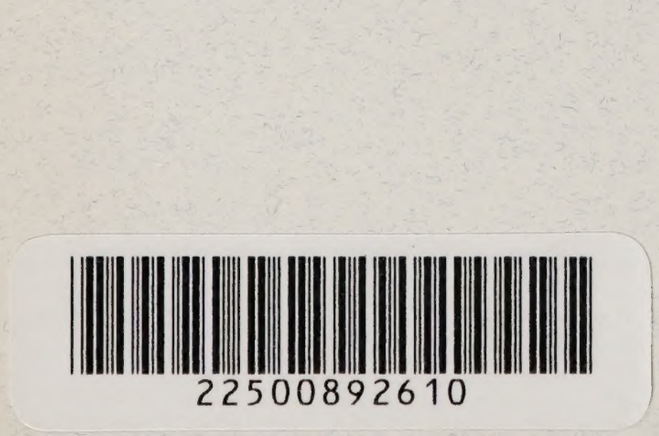

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AN OBSERVATION RELATING TO THE NATURE OF AURICULAR FIBRILLATION.

By THOMAS LEWIS.*

(*Cardiographic Department, University College Hospital Medical School*).

There are many questions relating to fibrillation of the auricles and ventricles to which no final answers can be returned at the present time. Fibrillation of a muscle mass is still but imperfectly understood and any account which pretends to explain the nature of the condition can only be regarded as a working hypothesis.

In writing of the condition known as fibrillation of the auricles I have repeatedly advocated the view that it results from the formation of new impulses in the muscle at a number of abnormal and ectopic foci. One of the most striking features of auricular fibrillation is the nature of the ventricular response. Fibrillation is never transmitted as such from auricle to ventricle, but the ventricle beats in a co-ordinate though perfectly irregular fashion. The responses are the result, as Fredericq[2] has shown, of impulses traversing the auriculo-ventricular bundle; they are impulses escaping in haphazard fashion from the quivering auricle. I have pointed out that similarly when the ventricle fibrillates the auricle responds irregularly to it,[2] an observation which has also been recorded by Cohn and Mason.[1] The auriculo-ventricular bundle, while conducting the impulses of a fibrillating auricle or ventricle, does so in a peculiar fashion. It evidently does not conduct all such impulses, but sifts them.

I may illustrate my working conception of a fibrillating auricle or a fibrillating ventricle and the events related thereto by a simple illustration. Imagine, in the course of a smooth and narrow stream, a sudden expansion (Fig. 1). A pool through which water flows to find exit in a narrow and confined channel. If a succession of waves is propagated on the surface of the water at the side of the pond remote from the outlet, they will travel over the pond. Each wave will spread over the surface of the water as an arc of an enlarging circle and eventually will meet the bank at all points. It will also spread to the outlet and will advance along it with its ends touching the banks and its general line at right angles to the course of the stream. Moreover, if the waves are propagated regularly at their starting point, they will travel along the outlet regularly. Such I imagine to be the analogous conditions in a regularly contracting heart, where the pool represents the auricle and the outlet the *A-V* bundle.

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* Aided by a grant from the British Medical Association.

But suppose the water in the same pool to be disturbed at a large number of separate points (Fig. 2), so that the whole surface is lashed into innumerable waves and ripples, travelling in many directions. What happens at the outlet? If this be sufficiently narrow the separate outgoing waves will be of the same form as before; the general line of each will be at right angles to the stream, and after the immediate outlet is passed they will no longer clash but will pursue each other in parallel course along the length of the stream. Nevertheless their succession will be a perfectly irregular one. Such I imagine to be the analogous conditions when the auricle is fibrillating.

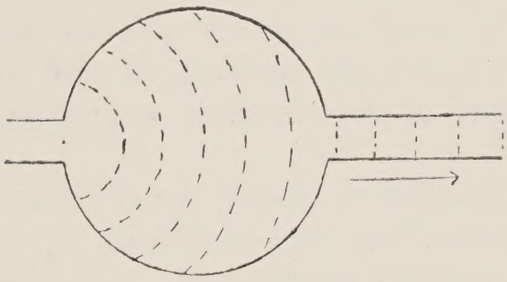

Fig. 1.

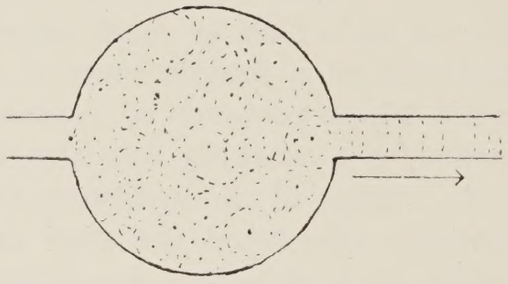

Fig. 2.

Fig. 1 and 2. Diagrams, illustrating the writer's conception of the paths taken by the contraction waves in the auricle. 1, while the auricle beats co-ordinately and 2, while it fibrillates.

The hypothesis has suggested a simple experiment. If it be correct, then the reason why the *A-V* bundle fails to convey fibrillation from one chamber to another is that it is a narrow channel.

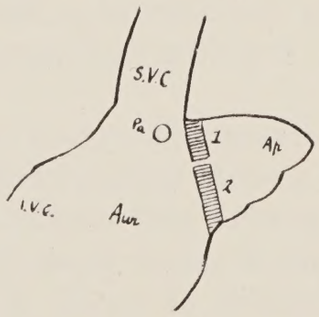

Fig. 3. A diagram of the right auricle, showing the positions (1 and 2) in which the clamp is applied to the base of the appendix. *Pa*—pacemaker.

For the purpose of the corroborative experiment, I have used dogs, anæsthetised with morphia, paraldehyde and ether. The heart is exposed and a fine suture run under the epicardium at the tip of the auricular appendix. Stretching the appendix, a strong clamp is applied across its base (Fig. 1), at such pressure as to break the softer muscular tissue without destroying the stronger epicardium and endocardium; the success of the crush is indicated by the transparency of the tissues directly after the clamp is removed. The crush is carried half across the appendicular base (1), starting

from the cavo-appendicular angle, and the clamp removed. The appendix regains its former outline and contains its blood. A second crush (2) is carried up towards the first from the *A-V* groove, so that the two almost meet. The muscle of the auricular appendix is thus isolated from that of the main mass of auricular tissue, except at two points, one in front and one behind. By twisting the appendix a little and reapplying the clamp, one of the bridges is easily broken without damage to the remaining one. The appendix is now in connection with the auricle by a single muscle bridge which can be reduced in size if it is desired.

The rest of the experiment consists in faradisation of appendix and auricle and observing the effects electrocardiographically. *When the auricle is faradised*, the usual fibrillation of auricle results and the ventricle beats quite irregularly in response to it. The fibrillation of the auricle is recognised by the disappearance of the *P* summits from the electrocardiograms and by the appearance of irregular oscillations (*f.f.* Fig. 5 and 6). It is difficult to state what happens to the appendix meanwhile, as its movements are confused by the irregular tug from auricle and ventricle.

If the appendix is faradised with the same current it is seen to fibrillate, but the auricle does not fibrillate, it beats rapidly, co-ordinately and irregularly. The relation of appendix and auricle which exists when the bridge of tissue is sufficiently narrow is precisely that of auricle and ventricle under ordinary circumstances. A fibrillating auricle produces co-ordinate but grossly irregular ventricular contractions. A fibrillating appendix produces co-ordinate but grossly irregular auricular contractions and the auricular disturbance is accompanied by a parallel, or almost parallel, ventricular action (Fig. 4, 7 and 8).

In the electrocardiograms the ventricular action is irregular but each ventricular beat is preceded by an auricular one. A gross irregularity, in which auricle and ventricle participate is seen.

Thus it is shown that the hindrance to the passage of fibrillation itself from auricle to ventricle or from ventricle to auricle is not necessarily the result of peculiar properties of the junctional tissues, but is more probably due to the simple narrowness of the tract along which the impulses course.

It is necessary that the bridge between appendix and auricle should be reduced to a millimetre or a little less before the desired result is obtained; the final stages in the reduction may be accomplished by means of a sharp and pointed knife. Complete destruction of the bridge immediately precludes the passage of any impulses which, if they traversed the bridge, would produce irregular action of the auricle.* If, under these conditions, the appendix is faradised, it fibrillates, while the auricle continues its regular beating.

The type of electrocardiogram obtained after crushing the base of the appendix and faradisation of the appendix is not without interest. The

* Fredericq has recently reported a similar observation (Archiv. internat. de Physiol., 1912, xii, 109).

bridge lies in the immediate neighbourhood of the pacemaker (*Pa*). It sends forth impulses and these originate contraction waves which course through the auricle in an almost normal direction. The auricular representative in the curve, which is distinct before each ventricular contraction, is of very similar form to that of the normal beat in the same animal (Fig. 7, 8 and 9).

There remains but a single consideration. If the appendix is faradised before its base is crushed, the whole auricle fibrillates; after the crushing, fibrillation is confined to the appendix. The fibrillation which results in the main mass of the auricle when, as in these experiments, a faradic current is applied by means of a bi-polar electrode to the appendix, is not due to simple spread of the current to the auricle; if that were so the main mass of auricle should fibrillate subsequent to the crushing. Fibrillation spreads through living tissue. The fibrillation of a muscle area distal to stimulation results from the state of surrounding tissue elements. As a bridge, having a sectional area of one square millimetre is sufficient to transmit fibrillation as such, it seems probable that fibrillation is induced in a given mass of tissue if an area of *fibrillating* muscle of these dimensions is in continuity with it. In this may be found the reason why fibrillation, when once established, tends to persist, for unless it is brought to a close in all parts of the auricle or ventricle simultaneously, the area in which it persists should maintain the condition in all adjoining areas.

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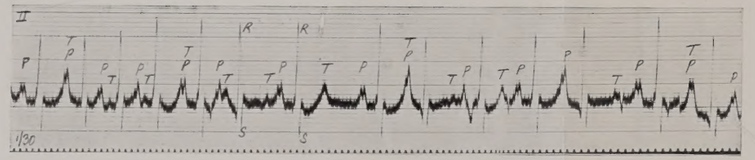

Fig. 4.

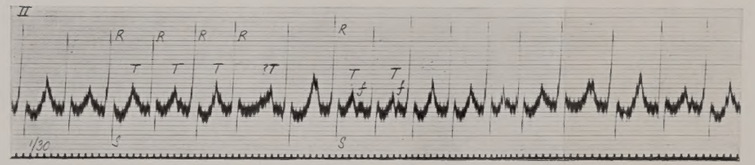

Fig. 5.

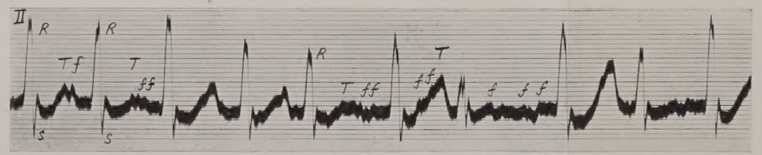

Fig. 6.

Fig. 4 and 5. Two electrocardiograms from a single animal and from lead *II*. Fig. 4 was taken while the almost isolated auricular appendix was faradised and fibrillated. Fig. 5 was taken while the body of the right auricle was faradised with the same current and fibrillated. Fig. 4 shows gross irregularity of the ventricular movements, but each ventricular beat is preceded by a well defined *P* summit, the result of co-ordinate contraction in the main mass of the auricle. Fig. 5 is a characteristic electrocardiogram from auricular fibrillation where the ventricle is beating rapidly and irregularly and where no *P* summits, but occasional *f* oscillations and distortions of *T*, are seen.

Fig. 6, 7, 8 and 9. Four electrocardiograms from a single animal and from lead *II*. The appendix has been almost isolated, a narrow bridge alone joining it to the right auricle. The main part of the right auricle was faradised and it passed into fibrillation ; the curve, Fig. 6, is characteristic of this condition. The appendix was faradised and fibrillated with the same current and curves, of which Fig. 7 and 8 are examples, were obtained. In Fig. 7, the ventricular beats are preceded by distinct *P* summits, which record the co-ordinate beats of the main mass of auricle. The heart beats are not regular, measurement and observation of the relation of *P* and *T* disclose differences in the lengths of individual cycles. The irregularity is more gross in Fig. 8, where the *P-R* interval varies considerably ; on one occasion the ventricle fails to respond to the auricular contraction, for the latter falls near the beginning of a ventricular systole. Fig. 9 shows the end of a period of auricular fibrillation, produced by again faradising the main mass of auricle. The return to the normal rhythm is seen ; the *P* summits of this period should be compared with those of Fig. 7 and 8. The time-marker is missing in Fig. 6 and 7 ; these curves were taken at precisely the same rates as those shown in Fig. 8 and 9.

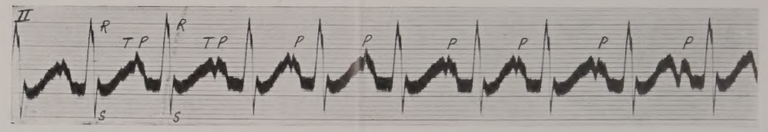

Fig. 7.

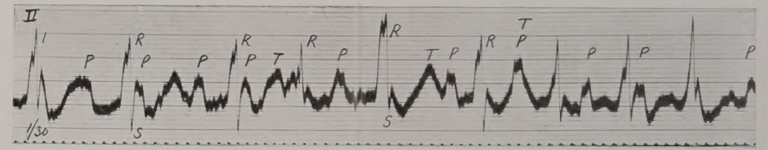

Fig. 8.

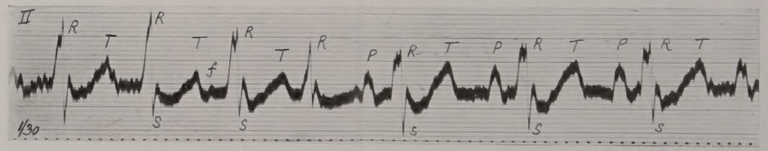

Fig. 9.

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